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Volume I—Report

THE INDUSTRY-GOVERNMENT AEROSPACE RELATIONSHIP

Prepared for:

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.
WASHINGTON, D.C.

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May 1963

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SRI Project No. IS-4216

PREFACE

It is the practice of the U.S. government to depend primarily upon private industry for the conception, the research and development, and the production of defense and space systems. The achievements of industry have helped to preserve the security and the international technical reputation of the country. However, many representatives of both industry and government believe that the industry-government relationship is not as creative, productive, or satisfactory as it should be, either to the nation as a whole or to the parties directly involved.

To provide bases for improving the effectiveness of this combined effort, Stanford Research Institute, under contract with the Aerospace Industries Association, has made a study of the industry-government aerospace relationship, which includes companies, large and small, that are contributing to the aerospace effort, together with the many government agencies concerned. For convenience, we shall often refer to this association as simply "The Relationship" or "The Aerospace Relationship."

The unique and especially fruitful aspects of the Relationship, as well as its weaknesses, have been examined in this study. Major problems confronting both government and industry in this close association have been noted, and suggestions for resolving them have been made.

The research approach included:

The seeking of views on the problems at hand from representatives of both industry and government.

The gathering of information on the nature and objectives of the agencies and organizations involved, and their operating relationships.

The collection and analysis of publicly available, as well as proprietary, financial and associated information of significance from the records of 27 aerospace companies, chosen as representative of the many high technology companies working on defense and space contracts.

The organization and analysis of especially assembled financial information for over 100 large U.S. manufacturing companies having predominantly nongovernment sales.

This study is oriented primarily toward policy-makers. The improvement of the Relationship will depend much upon the extent to which policy-makers in and out of government can recognize its strengths and correct its weaknesses. In making the study, SRI has kept to the forefront the importance of making the Relationship serve the public interest, as this interest is interpreted by public officials. This report suggests the need for a better balance of the major interests involved in the Relationship--the broad public interest--interests of different branches of the government--and interests of the industry itself.

Time constraints did not permit development of sound bases for judging adequacy of return to the industry, nor were industry labor problems investigated.

Detailed analyses, methodology, supporting data, and results of the research are presented in eight appendixes, which are contained in a separate volume: A. The Government Contract System as a Problem in Public Policy; B. An Experiment in "Disengagement"; C. Technical Program Management; D. Burdens on the Procurement Process; E. Impact of Statutes, Regulations, and Policies on Individual Companies; F. Trends in Government Procurement Policy; G. Financial Profile of the Industry; and H. Technical Profile of the Industry.

It is important to recognize the contributions of others toward the clarification of problems associated with the industry-government relationship and to recognize the inputs their efforts have provided to this study. The recent Bell report and the Harvard study on the Weapons Acquisition Process are examples of related work having an impact on the industry. The Logistics Management Institute has under way over 20 projects, all relating to the industry-government picture. The National Security Industrial Association (NSIA) Cost Reduction Study also is an important contribution. The 1962 Air Force Systems Command (AFSC) Monterey Conference has been followed by a series of research projects, the status of which is being reported at frequent intervals. In addition, the Brookings Institution is currently involved in a long-term study of the government procurement and contracting process and its implications for public policy. Also deserving of special mention are the efforts represented by many Congressional hearings on this topic.

Stanford Research Institute particularly appreciates the helpful suggestions, information, advice, and counsel received from many industry and government sources.

George T. Hayes
Project Manager

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SUMMARY

The present Industry-Government Aerospace Relationship is a remarkable politico-economic innovation. It is exceptional because it blends, in a workable arrangement, prime attributes of both our political and economic systems. Its importance takes on a new dimension because of the great amount of national resources involved. Its past success in achieving established goals makes it a unique American invention of which the nation can be proud.

There are, however, significant and difficult problems in this Relationship as it operates today. These problems must be resolved if the Relationship is to continue fully to meet its promise. During periods of wartime, the nation's politico-economic systems are a virtual single-purpose machine, the central dominant goal of which is to win the armed conflict. During such times, stresses and strains in industry-government relationships are suppressed in the interests of achieving that goal. During peacetime, however, the components of our economic and political systems have differing objectives. These are reflected in the Industry-Government Aerospace Relationship. The resulting conflicts and frictions must be resolved to preserve the essential creative ability that is inherent in the Relationship.

This summary itemizes briefly the significant trends currently affecting the Relationship, the problems that exist, their possible causes, some suggested actions, and some general observations.

Significant Trends Affecting the Relationship

Some of the more significant trends affecting the Industry-Government Aerospace Relationship are:

1. An increasing national and international pressure for spectacular technical advances.
2. A decreasing requirement for volume production of system hardware and an increasing attention to R&D.
3. A reduction in the number of large systems authorized and funded.

4. A move toward making single systems fill multi-Service needs.
5. Greater attention to system definition prior to contracting.
6. A centralization of major procurement decisions in the Office of the Secretary of Defense.
7. An increased emphasis on competitive award of contracts.
8. Increasing pressure for more general geographic distribution of contracts.
9. Increasing use of cost-plus-incentive-fee contracts rather than cost-plus-fixed-fee contracts.
10. Increasing pressure on industry to assume a greater share of the risks inherent in defense-space activity.
11. Increased detailing of procurement regulations and closer government supervision of contractor activities.
12. Increasing military attention to relatively unsophisticated, conventional warfare systems.

Major Problems Existing in the Relationship

Major problems now present in the Industry-Government Aerospace Relationship include:

1. Industry's growing concern that its technical performance, costs, income, and reputation are being affected adversely by

over-regulation,

conflicting regulations,

ineffective administration of regulations,

close, and not always capable, government surveillance of its activities, and

burdening of the procurement process with socio-economic objectives.

2. The attitude of many government officials, based on past experience, that without close supervision or risk-carrying incentives, industry cannot always be depended upon to fulfill its contractual obligations on time or at reasonable cost.
3. The general belief of industry's executives that the government's often inconsistent, loosely specified, but increasingly stringent attitude concerning allowable costs is detrimental to the industry's well-being.
4. Disagreement between industry and government over the profit rate that constitutes an adequate return. This disagreement stems largely from varying opinions concerning the extent of risks to be borne by the industry and industry's cost in maintaining an advancing technical capability.
5. The absence of a "free-market" environment in which industry and government do business, which requires special attention to the balancing of capacity with requirements. The means to accomplish this desirable objective have yet to be worked out.

Possible Causes of Problems Affecting the Relationship

Among the possible causes or sources of problems affecting the Industry-Government Aerospace Relationship are:

1. The seeming lack of complete mutual confidence and respect between industry and government.
2. Absence of a clear understanding and of a general acceptance of industry's and government's proper roles in the Relationship by all levels of the business community and by all federal employees concerned.
3. Industry's failure to appreciate fully the nature of the often delicate interactions that must take place between government agencies in reaching decisions of importance to the Relationship. Also, industry may not realize the full significance to government officials concerned or to the industry, itself, of the unfavorable reactions resulting from contract schedule slippages and overexpenditures.

4. The failure of government representatives, in turn, to recognize or admit to the impact on industry's performance of conflicting, vague, voluminous, and changing regulations, and their inconsistent interpretation and administration.
5. A tendency on the part of the Services as buying agencies to devote too little attention to the formulation of requirements, thereby specifying needs too generally, using the need for action and flexibility as justification. Auditing of technical factors is difficult.
6. In contrast, cost and contract audits are easily and frequently made. The result may be that Congress and the buying agencies pay too much attention to preventive legislation and regulation. In this way, the transgressions or failures of some become the bases for continuing burdens and expense to all.
7. Congress, in attempting to protect the public interest, has enacted legislation and established agencies whose subsequent actions, vis-a-vis industry, are not fully coordinated and are frequently conflicting.
8. The flexible, cost-plus-fixed-fee contracts applied to programs involving high technological risk have led to some inefficient practices and increased costs in both industry and government.
9. The detrimental impact on delivery schedules and cost targets of program changes encouraged by generalized specifications may not be fully appreciated by either industry or government.
10. Even though some key government procurement officials admit to "overmanaging" industry, and express the desire to "disengage," steps to do so have been limited to the application of cost-plus-incentive-fee type contracts and study of regulations that might be relaxed when such contracts are employed.
11. The government's reduction of facility funds and limitations on progress payments are shifting to industry a greater burden in maintaining an adequate aerospace capability. This shift is well under way. However, there has not been agreement on the extent to which the risk should be shared between industry and government or on the level of industry compensation warranted.
12. The relationship between industry and the government, until recently, was of great material and economic consequence only

during actual war. Major industrial activity in support of the national defense in peacetime accounted for a relatively small portion of the nation's Gross National Product (GNP). Since Korea, however, world tensions and weapons capabilities have required the maintenance of an aerospace industry activity that alone generates about 3% of our GNP and an even greater proportion of U.S. manufacturing volume and employment. Thus, location and relative efficiency of this industrial operation have become matters of current national interest and concern, and some political activity. This has increased the stresses and strains in the Relationship.

13. However much it might wish to the contrary, a major portion of the industry is not "free enterprise" in the classic sense of the term, and does not operate as such. Because of its almost complete dependence on the government, it seldom takes firm positions in opposition to the government's desires, however justified.

Some Suggested Actions

A number of actions can be taken to improve effectiveness of the Industry-Government Aerospace Relationship. Following are some that have become apparent as possibilities during the course of this study.

1. To be initiated by industry:
 - a. Encourage government's "disengagement" from its position of overmanaging industry, by developing and suggesting simpler, more effective, and less costly surveillance techniques.
 - b. Assist in crystallizing and adopting a uniform and fair performance evaluation technique, a study of which is currently under way.
 - c. Take steps to consolidate and present industry's points of view on critical issues, while also giving sufficient recognition to the merits contained in divergent views.
 - d. Proceed with studies to determine industry's risk and relate it to required rates of return, investment requirements, and similar measures of the adequacy of the industry's over-all performance.

- e. Encourage the adoption, on an individual contractor basis, of principles for guidance in government relationships.
- f. Encourage additional meetings between industry and government to discuss common problems. Be prepared to offer factual evidence of needs for change.

2. To be initiated by government:

- a. Intensify efforts to determine requirements and define programs before initiating development contracts.
- b. Through contractor performance evaluation, depend increasingly on end performance rather than detailed in-process review in the monitoring of contractor activities.
- c. Policy level offices of the Department of Defense, NASA, and AEC should initiate whatever steps may be necessary to assure implementation of policy at all working levels.
- d. Initiate efforts to simplify the organizational structure and reduce the costs of contract surveillance.
- e. Conduct and encourage further study of contracting and its implications for public policy.

3. To be initiated jointly by industry and government:

- a. Undertake to simplify regulations and eliminate conflicts and confusion.
- b. Organize and conduct a series of top-level industry-government-wide policy discussions on the nature of mutual problems, toward agreement on solutions.
- c. Organize and conduct a series of educational seminars for industry and government working-level liaison personnel to improve understanding and application of policies and procedures.

General Observations

1. In spite of its imperfections, the Relationship has achieved sufficient technical performance to maintain the nation's security and to assure successes in space.
2. Industry is usually blamed for the fact that the Relationship is not as creative, productive, or satisfactory as it should be. As a consequence, industry must either assume a more assertive role in developing the rules of the Industry-Government Aerospace Relationship, or see its own effectiveness continue to diminish.
3. For the first time in its history, the aerospace industry is experiencing a relatively high and stable sales volume. There has been a substantial increase in company assets and a reduction of government progress payments. One group of aerospace companies studied has been investing over \$200 million a year in plant and equipment since 1955, as compared with less than \$50 million a year prior to 1950. Another group has increased its own working capital to offset a reduction of government progress payments from over 25% of government sales prior to 1957 to less than 15% since 1958. Thus, the industry has more of a financial stake in its future than ever before.
4. A study of the earnings of a limited but representative group of aerospace companies for the period 1947-1961 reveals greater variability than for a broad cross-section of U.S. manufacturing corporations. From a median return of 5.0% on total company-reported assets annually in the 1947-51 period, aerospace earnings rose to 9.7% annually during 1952-56, and decreased to 7.1% in 1957-61. In comparison, cross-section company earnings were 11.2%, 8.6%, and 7.3% for the same periods (ref. Table I, p. 50). The aerospace industry group's median return on net worth moved from 9.5% to 20.8%, and down to 11.3% during the same 5-year periods, as compared with 15.8%, 12.0%, and 9.8% for the broad cross-section of U.S. manufacturing concerns.
5. The drop in aerospace industry annual earnings from 9.7% of assets in 1952-56 to 7.1% in 1957-61 appears to be largely due to (1) an increase in the percent of low-yield, fixed-fee R&D contracts and a decrease in the percent of more remunerative, large production-run contracts; (2) an increase in the employment of company assets in relation to sales; and (3) losses on commercial jet aircraft charged off during 1957-61.

6. Current government policies call for the transfer to industry of the risk associated with maintaining adequate facilities and personnel to meet future space and defense requirements. Current government contractor compensation practices do not appear to give adequate recognition to the added compensation warranted by the increased risk.
7. Geographical concentrations of the industry's activities and their highly specialized nature tend to commit the government to continuing use of available company facilities or capabilities for economic reasons.
8. Despite Congressional pressure to diffuse defense and space subcontracts geographically, a study of eight major contractors' subcontracting patterns indicates that efforts to do so have been relatively ineffective.
9. The cost to the public of developing and producing a weapon or space system is the sum of the price paid the contractor for his efforts and a portion of the cost of operating the procuring agency as well. Excesses must be avoided in both categories.
10. The technical characteristics of the industry have changed considerably since 1955. The number of salaried employees has increased from 25% to 46% of the people employed by the 27 companies studied. As a part of this change, the number of employees classified as engineers and scientists rose from about 10% to over 16% of total employment. Floorspace devoted to manufacturing declined from about 52% to less than 40% of total space; amounts devoted to laboratories and offices moved upward from about 18% to over 28% of the total.
11. Even more dramatic than the increase in technical personnel has been the rising number of managers, schedulers, controllers, and procurement and overhead services people for the companies studied--up from about 14% in 1955, to over 29% of people employed between 1955 and 1961.
12. With the latest deterrent hardware going into operation, it is important for industry to assess the level of future activity expected of the industry by the government. The cost of operational system maintenance and other pressures may cause funds to be diverted from hardware and R&D budgets.

13. The growth of the U.S. economy depends on the vigor and initiative of private enterprise. The aerospace industry employs almost 20% of all the scientists and engineers in the country. To the extent that it is private enterprise in the classical sense, the industry may not be doing as much as it can in the public interest, or should in its own interest, to apply and transfer its knowledge, skills, and innovations to commercially useful products.

POLICY CONSIDERATIONS AND PURPOSES OF THE RELATIONSHIP

The recent experience of the country suggests that there will be a long-continuing requirement for a high level of military preparedness and scientific activity. The government has the responsibility for maintaining the United States in a state of military readiness. In addition, continuing scientific accomplishments in Space, the current arena for international technical competition, must be assured. The government must do these things in ways that are in the public interest and with the means available. In this regard, government arsenals and laboratories are outstanding for certain kinds of work. It is a basic tenet of our society, however, that private industry, as the key to the vigor of the economy, must carry the major burden of developing and producing military and space hardware. This results from many pressures in the public sphere, both economic and political, as well as from a noteworthy record of innovation and production performance on the part of private industry.

Our view in examining the Relationship is from the standpoint of the not-too-well-defined but frequently referenced "public interest," which, to the individual citizen, certainly includes:

1. National survival--The threats to survival of individual freedom in the United States and abroad and to our survival as a nation have increased manyfold since World War II. The world conflict in which this survival is at stake ranges from ideological conflict, through economic and scientific conflicts, to local conventional arms conflict, and the stalemated thermonuclear threat. The ability of the nation to respond to threats largely depends on the accomplishments of the Relationship.
2. World leadership in scientific achievement--Demonstrated achievements in science and space technology are just as much requisites of national prestige and security as are superior and operationally ready weapons. Technological advances, now accelerated by extensive government support, will continue to present challenging possibilities for application to weapons and space feats. To the extent that scientific understanding becomes public knowledge, the advances will be exploited to greatest advantage by the most facile country technologically, not necessarily the country responsible for the advance.

3. A viable, private economy--Basic to the vigor and growth of the U.S. economy is a healthy, expanding, creative private industry.
4. Efficient use of national resources--However rich the country, its resources in manpower and material are limited. They must be used wisely, not wastefully. Basic to efficient use of resources is a clear determination of requirements between the public and private sectors of the economy and among those activities designed to defend the nation and those that will contribute directly to its economic vitality.

Essentially, the Industry-Government Aerospace Relationship is involved in making available to the using branches of the government the wherewithal--or hardware--for protection and prestige. This is not a simple, straightforward process. It requires a delicate matching, by the government, of the pressures and demands of the international balance of power with those of domestic politics. Guidance for this effort cannot be deduced from a simple statement of national objectives. Rather, it results from a competition of purposes among the individuals and groups in the Relationship. As currently pursued in the United States, it is oftentimes the result of politics rather than logic--politics honestly practiced, with no sinister implications.

Out of this competition of purposes must come the establishment of requirements by government, drawing upon industry for ideas, and their fulfillment by the aerospace industry. To protect the public interest, the government, as the buyer, "regulates" the aerospace industry. This regulation is not accomplished through an independent commission before which both the public and the industry can present their cases, such as with public service industries. It is accomplished, rather, unilaterally through procurement regulations and other provisions that may be included in government contracts. These regulations and provisions range from those designed to protect the government as a customer, to many social and economic objectives. Post-audits and renegotiation of profits are also means by which the government protects the public's financial interests. As applied through contracts, these regulations and procedures, to some degree, transform the members of the aerospace industry into closely controlled agents of the government for the operation of "arsenals" for modern weaponry and space exploration. The anomaly is that the aerospace firms are expected to act with the drive, efficiency, and flexibility usually attributed to private enterprise.

Because of the nature of the contract relationship, industry has no point of appeal. The initiators of the laws basic to these regulations, the offices created, and the officials who must interpret the regulations

guard the public interest in their own way and sometimes toward their own official ends. The Congress authorizes, appropriates, and investigates, and it applies pressure that sometimes appears to be more political than in the nonpartisan public interest. Some feel that government boards tend to act on the basis of the personal leanings of their members, legal instructions always being subject to some interpretation and emphasis.

As a part of this Relationship, industry sees its job, primarily, as that of suggesting new possibilities and of meeting its contractual obligations. In addition, however, the Relationship is used by individual companies in their self-interest, to further their own legitimate corporate ends, just as it is by government officials for the ends of the government and the public.

This close industry-government relationship represents something new under the American sun. Its operation affects public policy, not only in the programs where contracting is actively used, but on such general matters as economic growth and the preservation of private economic enterprise. By enlisting private organizations in the performance of public functions, government involves them in politics and makes it necessary that they be held publicly accountable in much the same manner as a government agency. This blurs the line between "public" and "private" and as the amount of contract work increases, emphasizes the urgency of the need for clarification of the public policy issues involved.¹

Industry, thus, must learn how to retain the advantages that private enterprise offers society, while serving the vital needs of the nation and selling to a customer with formidable bargaining power. The government, in turn, must learn to distinguish between (1) those regulations that protect the public's financial interests without jeopardizing the national security, and (2) those regulations where short-run financial savings are outweighed by the loss of industrial incentive and creative ability. The government must also learn the extent to which it can burden its contractors with its socio-political objectives, such as special subcontracting considerations, without seriously reducing their efficiency.

It goes without question that industry will have to learn to work in an increasingly regulated environment or take the initiative to modify it. Currently, because of failure of certain systems to materialize by the

1. See Appendix A, "The Government Contract System as a Problem in Public Policy," for a more detailed discussion of these views.

dates and within the cost limits initially estimated, industry is being overwhelmed with government red tape and surveillance. It is a period of discomfort and disenchantment on all sides, and both industry and government recognize that steps must be taken to improve the Relationship. Industry is of the opinion that greater freedom from government control and supervision would stimulate performance, and that industry should be more adequately compensated for its efforts. Government, on the other hand, feels the obligation to assure itself that effective hardware is made available on a timely and efficient basis. The difficulty is that the hardware is of a very sophisticated nature. Special capabilities are required in industry to create it, and a special relationship between government and industry is involved in conceiving it. Thus, the relationship is not that of the typical buyer and seller. Rather, it represents a unique intermingling of public and private functions, the governing rules for which have not yet been fully evolved.

Only a limited segment of U.S. private industry is equipped to undertake the hardware development tasks required for national defense and space operations. So specialized and extensive is the current requirement in terms of facilities, talents, and technology that there is little alternative but for the companies involved to continue to devote their principal attention to government contracts. They must be ready to fulfill government requirements for hardware because they are the only major source, and yet be flexible enough to survive if government demands slacken.

The government, committed to the use of private industry, must do so in ways that assure:

1. Timely availability of necessary hardware,
2. Equal opportunity for contracts to all companies capable of performing,
3. Sufficient flexibility of planning and procurement scheduling to avoid a wasting of resources, and
4. Maintenance of a continuing and ever-advancing, specialized industrial capability available on demand.

Thus, there is risk involved on the part of both government and industry.

The key issue involved, from the standpoint of the public, is how the risk can be distributed most equitably between industry and government--in the public interest. Specifically, the risk on the government

side is that of failure to have the necessary weapons or to demonstrate the most advanced space capability at the right times. The risk faced by industry is that of survival. Individual companies cannot, necessarily, be guaranteed survival regardless of any mistakes they might make in the direction or size of commitment of company resources. They are, after all, dealing in a fiercely competitive one-customer market.

By accepting the obligation to provide or maintain necessary facilities, industry assumes some risk in exchange for the opportunity to obtain contracts that will yield some measure of profit. That profit must be sufficient over the long run, and with due consideration for the limits of human foresight and effectiveness, to assure a continuing and technologically advancing industry capability.

ROLES OF THE PARTICIPANTS, AND EMERGING PROBLEMS

Government and Industry Tasks

As the buyer of R&D or sophisticated systems, the government's procurement task is theoretically very clear. Fundamentally, it is to:

Identify its needs,

Request proposals covering the products or services desired,

Select the best qualified supplier,

Maintain liaison with the supplier and undertake acceptance inspection of his work, and

Put the product to use.

In practice, the task is anything but clear and simple, particularly when applied to the aerospace business. In addition, the results are oftentimes longer in coming (1.36 times) and more costly (as much as 3.2 times)¹ than originally anticipated. The causes of this situation may be fully recognized but they are not entirely under anyone's control.

In examining the government's role as buyer of defense or space systems, one must consider many offices in addition to the procuring office itself. These include the Office of the President, the Central Intelligence Agency, the Department of Defense or National Aeronautics and Space Administration or Atomic Energy Commission, the State Department, the Congress, and a number of independent agencies. The matter of buying is only one of a number of complex and related tasks faced by government in carrying out its responsibilities. Moreover, technology, world events, and the tides of domestic politics are changing swiftly. This, in comparison with the relatively slow hardware development process, requires an almost continuous sensing, adapting, modifying, and redeploying process in order to minimize the public risk.

1. Peck and Scherer, The Weapons Acquisition Process (Boston: Harvard University, 1962), Table 2.1, p. 22.

As the seller of materials and services, industry's task can be stated in as straightforward a manner as that of the buyer, to:

Maintain a capability for R&D and production,

Continuously develop new ideas and submit them for consideration,

Respond to government requests for proposals,

Carry out requisite R&D,

Produce and deliver the products to specification and on schedule as efficiently as possible, and

Realize an adequate profit.

Actually, industry's task is no less complex than that of the customer. It is complicated manyfold, not only by the changing possibilities offered by advancing technology and by the transitional status of international events, but also by the fluid state of funding, organization, product requirements, and personnel of its customer--the government. In addition, and as an element of risk over and beyond the basic one of maintaining a capability that may not be needed, industry faces the government's unilateral right to cancel its procurements and retroactively to reduce the prices paid.

Many of the concepts upon which industry-government contract relationships are currently based grow out of earlier procurement practices designed for tightly specified off-the-shelf type items. They assume that all activities should be carried out at "arm's length" under a basically laissez faire system. The magnitude and complexity of the tasks involved in today's weapons and space developments, however, have required a very close contractual and technical working relationship between government and industry. Government and industry have entered into close association in the following areas: (1) research, development, testing, and engineering; (2) weapons systems procurement; (3) management of operations of various kinds; and (4) consultant type services.

Although industry is the source of many of the ideas for hardware systems, today the initiative for even the first step of the development process--demonstration of feasibility--usually rests with the government, because of the cost. This represents a significant change from the past, when individual companies could more readily afford to build demonstration aircraft and the like. This fact alone, more than any other, has contributed to industry's uncertainty about its future business, and is the

reason for an attitude expressed in the statement, "The managements of our defense industry obviously and logically are often more concerned with getting the contract than they are with managing it after they get it."¹ The sensibility of this attitude, from the standpoint of corporate survival, is further reinforced by actual experience,² the fact that past performance is not necessarily a major factor in the awarding of new business, and the current lack, at least in the Department of Defense, of a reasonable and generally applied method of contractor performance evaluation.³ The fact is, however, that the government must rely on industry to meet its objectives.

The seriousness with which industry is concerned about its future is attested by the estimate that 18% of the industry's top scientific and engineering talent are working on proposals rather than on project accomplishment.⁴ Although about 75% of this effort is spent on unsuccessful proposals, based on current proposal acceptance experience, the effort is considered by many in both industry and government to be worthwhile. Each unsuccessful effort is said to ensure better understanding and capability for the next attempt. A spot study suggests, however, that there is waste, particularly in smaller competitive procurements, where it is reported that often the cost of the efforts involved in the competition, both for proposal writing and for proposal reviewing, exceeds the value of the contract awarded.⁵ A substantial part of these costs are borne by the government either directly or through reimbursement of defense contractor overhead costs.

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1. Barry J. Shillito, President, Logistics Management Institute, in a speech before the Procurement Management Conference, Williamsburg, Va., Feb. 14-16, 1962.
 2. As pointed out by Simon Ramo, Vice-Chairman and Director, Thompson Ramo Wooldridge, in a speech before the American Rocket Society, quoted in Aviation Week, Jan. 8, 1962, p. 99ff.
 3. The AEC has a formal contractor evaluation technique currently in use. The DOD, through the Defense Industry Advisory Council, is in the process of formulating a method.
 4. C. F. Horne, "The Impact on Business Firms, I.," Research Management, Vol. 5 (September 1962), p. 331.
 5. R. B. Chapman III, Executive Vice President, Aircraft Armaments, Inc., "Compatibility of Recent Legislation and Regulations with 'Cost Reduction' and 'Incentives,'" an unpublished paper dated Sept. 20, 1962.

The basic question of what activities can properly be delegated to industry by government through contract is a debatable one on which experimentation is continuing. The delegation of authority to industry under the weapons systems management concept of the early 1950's was not entirely successful. As a result, and because of increasing system complexity and cost, there has been a recent growth in government supervision and control mechanisms. Faced with cases of inadequate contractor performance, top government officials, under pressure from review agencies, feel they have no choice but to exercise direct administrative control in order to ensure performance.

A recent Air Force management audit of six major contractors holding contracts for about 25% of the defense procurement dollar revealed 13 deficiencies considered by the Air Force audit team to be of major importance.¹ Although these shortcomings were significant, this may be a case of the pot calling the kettle black. In 1958, the Air Force refused to release to the GAO the results of a not too favorable audit of a part of its own operations.²

That the Relationship is effective despite inadequacies is attested by its many visible products such as operationally deployed missiles, radar defenses, supersensitive reconnaissance equipment, and successful space shots. That it could be made more so with much less effort and frustration has been demonstrated by occasional carefully controlled experiments involving picked people, limited state-of-the-art advances, and freedom from too much "help" from higher levels of authority. In one such case, a satellite boost vehicle was delivered in half the time originally estimated for its completion, after being set up on a "hands-off" basis.³ Although it is the announced desire of the Air Force to disengage itself from "overmanaging" industry,⁴ experiments such as these

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1. Maj. Gen. W. T. Thurman, Director of Procurement Management, Department of the Air Force, in speech to the Government Contract Management Association's Institute on Government Procurement Problems, Boston, Mass., Oct. 18, 1962.
 2. Refusals to the GAO of Access to Records of the Executive Departments and Agencies, Report by Comptroller General of the United States for Committee on Government Operations, U.S. Senate, 86th Congress, 2d Sess., June 14, 1960 (particularly AF Inspector General's Report).
 3. The Agena D. See Appendix B for additional details.
 4. J. S. Imirie, Assistant Secretary of the Air Force (Materiel), in speech before Stanford Business Conference, Stanford University, Palo Alto, Calif., Sept. 15, 1962.

are not considered by the Air Force to be entirely valid in indicating the bases upon which such withdrawal should be attempted.

The Anatomy of the Relationship and its Conflicts

The achievement of the national objectives of security and leadership in space exploration has required the participation, in one way or another, of a number of separate government agencies as well as thousands of individual business and industrial organizations. Conception, design, construction, and operation of complex space and weapons systems are a continuing effort, accompanied by frequent audits and investigations. Collectively, the industrial and governmental units concerned with aerospace activities agree generally on the over-all objectives of maintaining the national security and prestige of the United States. Individually, the separate government agencies and the private companies that provide the framework for their accomplishment have differing functions, objectives, and incentives. These differences inevitably create friction and problems that must be minimized.

The agencies directly involved in the Aerospace Relationship can be classified as:

Offices establishing over-all security and policy objectives,

Agencies involved in establishing the requirements leading to systems for meeting the objectives,

Users of the systems,

Acquirers of the systems,

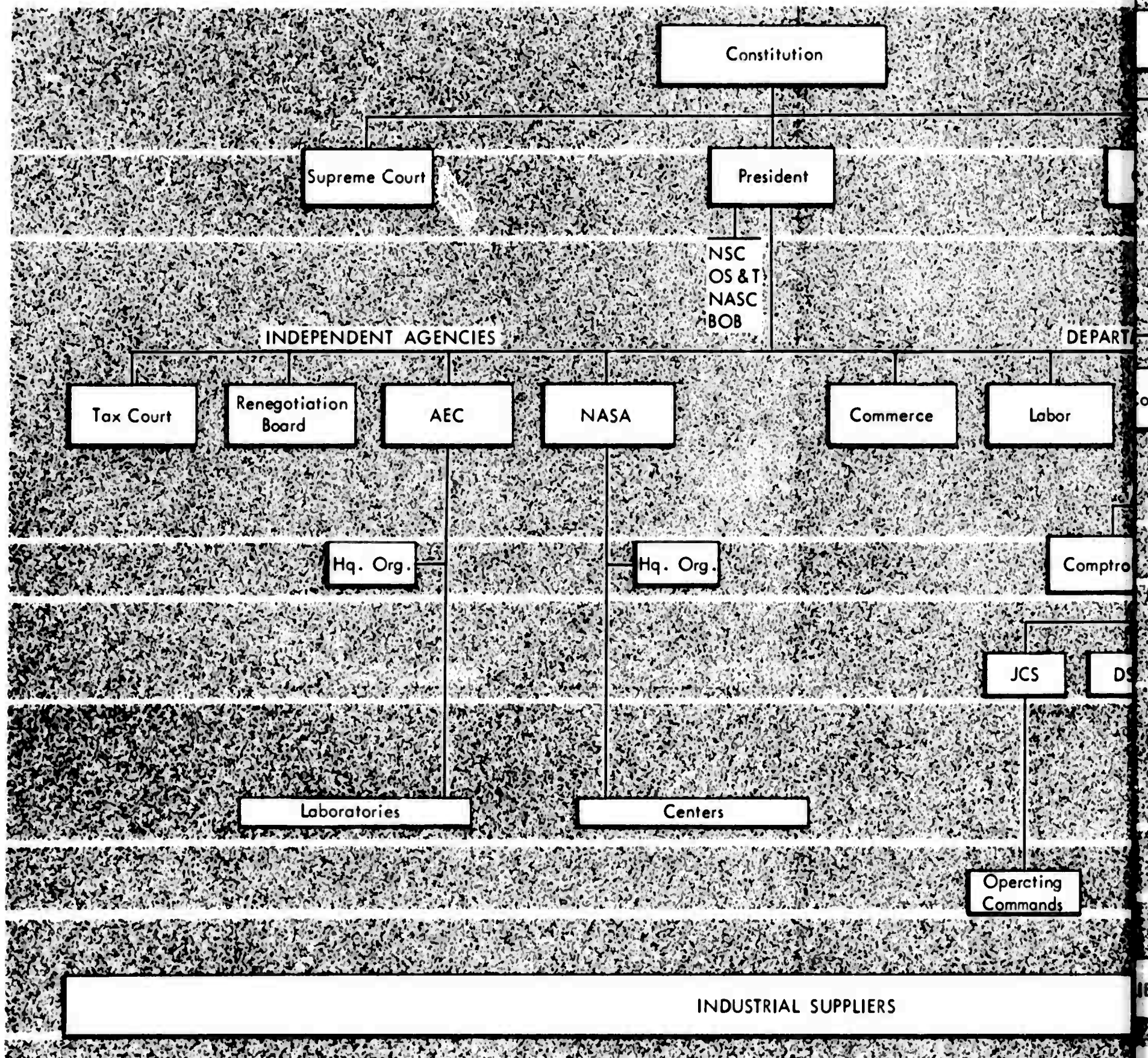
Reviewers, and

Suppliers.

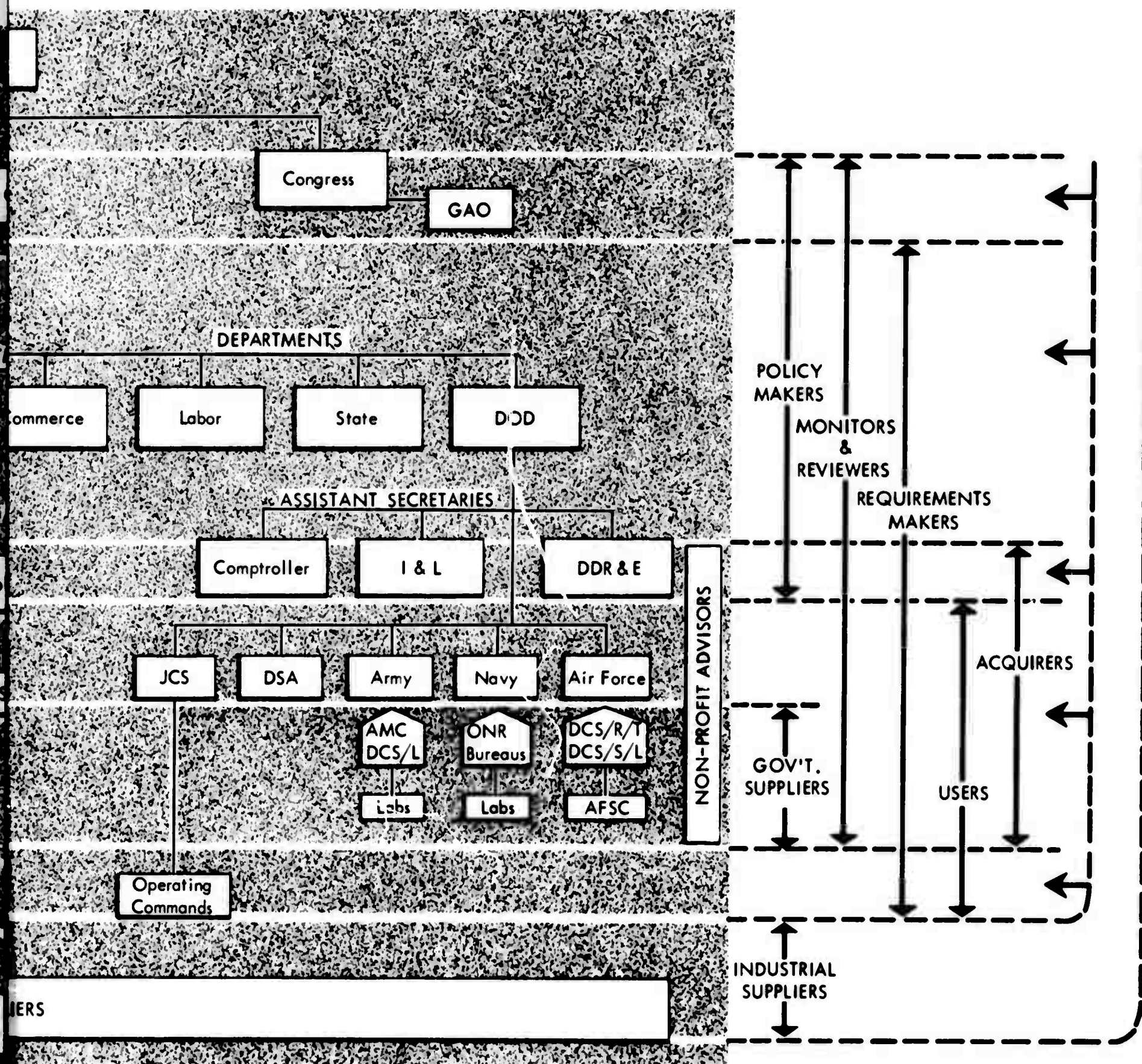
The hierarchical relationships and functional classifications of the agencies most directly involved in the Relationship are shown in Figure 1.

1. Policy Offices. The Congress, through its authorization and appropriation committees, and the President and his staff, are the primary agencies establishing national objectives in space

FIG. 1
HIERARCHICAL RELATIONSHIPS AND FUNCTIONAL CLASSIFICATION OF AGENCIES
MOST DIRECTLY INVOLVED IN THE AEROSPACE RELATIONSHIP



SOURCE: Stanford Research Institute.

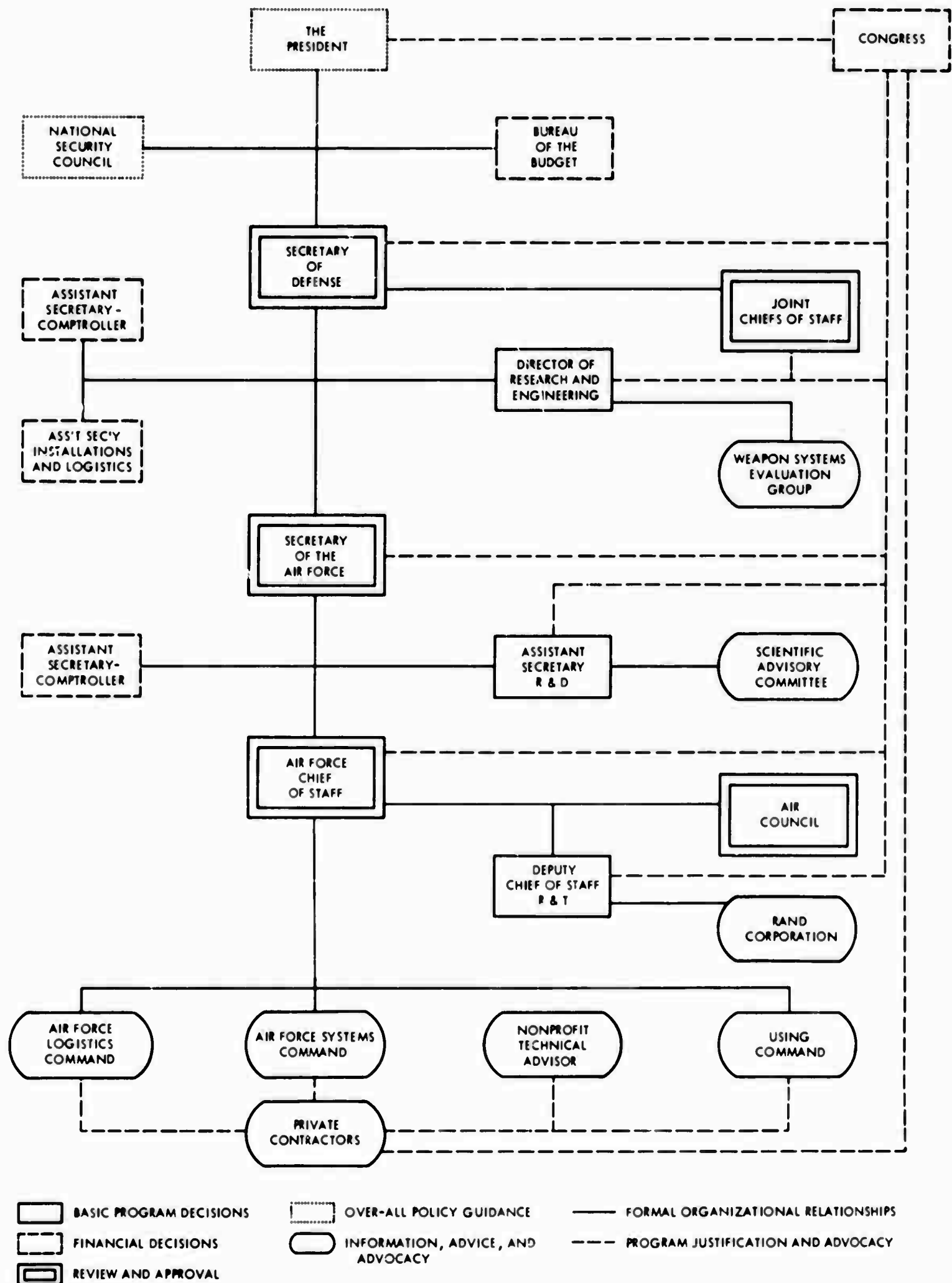


exploration and national defense.¹ Their decisions have direct bearing on the size and nature of the total effort involving security and space. The members of the National Aeronautics and Space Council advise and assist the President regarding policies, plans, and programs. They fix the responsibilities of U.S. agencies engaged in aeronautical and space activities.

2. Requirement Agencies. Requirements result from the actions of many groups in DOD, NASA, and the AEC in the planning involved in the implementation of basic policies. It is a complex process that involves review and approval at many levels.² For example, the offices involved in a decision to initiate a major program in the development of new weapons systems in the Air Force are shown in their organizational relationship in Figure 2.
3. Users of the Systems. The users of the systems, the major military commands and NASA and AEC units, have the principal objective of obtaining the system with the highest technical capability in the shortest possible time. Costs and other considerations are secondary to the user. Indeed, evaluation of hardware performance by the user tends to be based upon the fact of accomplishment, rather than upon cost or cost-benefit considerations.
4. Acquirers of the Systems. Acquisition of systems and components takes place at many points in the government. Procurement and contracting units are dispersed among the services and their major commands and among the major NASA and AEC divisions and

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1. "Much of the political process for the integration of ideas and the mobilization of consent, however, takes place before, through, and within the congressional bodies. . . . The congressional body, not the executive branch, has the onerous political responsibility of working out the language which will secure the largest measure of acceptance."--S. P. Huntington, The Common Defense (New York: Columbia University Press, 1961), p. 155.
 2. That this process is not only complex but apt to yield unspectacular and tardy results is a view held by many. J. S. Livingston, "Decision Making in Weapons Development," Harvard Business Review, January-February 1958, pp. 127-136.

FIG. 2
GROUPS INVOLVED IN A MAJOR AIR FORCE PROGRAM DECISION



Source: Adapted from Paul W. Cherington, Merton J. Peck, and Frederic M. Scherer, Organization and R&D Decision Making Within a Government Department, *The Rate and Direction of Inventive Activity: Economic and Social Factors*. National Bureau of Economic Research (Princeton, N. J.: Princeton University Press, 1962), p. 397.

field activities. The acquirers of the systems must give due consideration to costs and other factors. Their objectives, to acquire the most efficient systems consistent with delivery time and cost factors, often clash with the objectives of the user as well as with those of the seller.

5. Monitoring and Review Agencies. Throughout DOD, NASA, and the AEC there are many groups concerned with monitoring contractor performance, reviewing and auditing costs, and administering contracts. In addition, the General Accounting Office reviews the performance of government procurement agencies themselves as well as that of their contractors.

Congressional committees are also concerned with the process, and perform a valuable function in the public interest in their investigations dealing with the procurement process and other aspects of industry-government relationships.

Finally, the Renegotiation Board reviews the financial performance of contractors to determine if profits from work on government contracts have been excessive in its judgment, based on several nonspecific criteria. Its claims can be appealed to the Tax Court of the United States, which, in turn, has its own criteria for judgment. Further appeals to other courts are also possible.

6. Suppliers. Both government laboratories and centers, as well as industry, serve as suppliers, with industry performing the major portion of the work. The access to all levels of government that is industry's privilege is a mutually advantageous yet complicating element of the Relationship. The procurement officer, oftentimes, appears to be the least important person to be convinced of the merits of one system over another.

Examples of conflicts in policy and practice resulting from the differing functions, objectives, and incentives of the agencies involved include, for example:¹

1. See Appendix E.

1. Renegotiation vs incentive contracts.
2. Subcontracting requirements vs reduced profits on subcontracted work.
3. Social and economic objectives vs procurement efficiency.
4. Government rigidity through detailing of procurement regulations vs procurement efficiency.
5. Protection of proprietary rights vs competitive reprocurement.
6. Allowable costs, patent rights, and indemnification policies as viewed by one agency vs those authorized by others.

The Working Relationship

As an example of the working relationships between and among the several types of agencies involved in the Relationship, we can diagram the four principal phases in the process of transforming the public interest in, and needs for, aerospace systems into the required operational end items. The relationships of the four phases are shown in Figure 3. The analysis of the conceptual phase, in which the resources required for program definition are determined, is shown in Figure 4.

The public interest is depicted as an element of the political, social, economic, and industrial environment. It exercises an influence on both the legislative and the executive branches of the government and is the source of the necessary monetary, human, and physical resources. The conceptual phase, always uncertain in its initiation of new possibilities, includes planning to achieve the desired results and the definition and approval of the various programs required to implement the plans, as well as modification of the programs as they are carried out in order to meet contingencies that may arise. This is the least systemized and yet the most vital part of the entire process of transforming needs into systems. It is here that the state-of-the-art, the environment, the resources, and the probable operational demands must be blended together many years in advance of actual hardware need. In the end, it is more a combination of genius, foresight, luck, controversy, bargaining and, sometimes, unyielding determination, than systematic procedures that bring to the fore the candidate systems ultimately found worthy of development. In this regard, the executive departments of the government serve as agents in the public interest, with many ideas originating in industry. The government then administers the programs through contracts with the supplier, as shown in Figure 5.

FIG. 3
PHASES IN THE TRANSFORMATION OF NATIONAL NEEDS
INTO OPERATIONAL END ITEMS

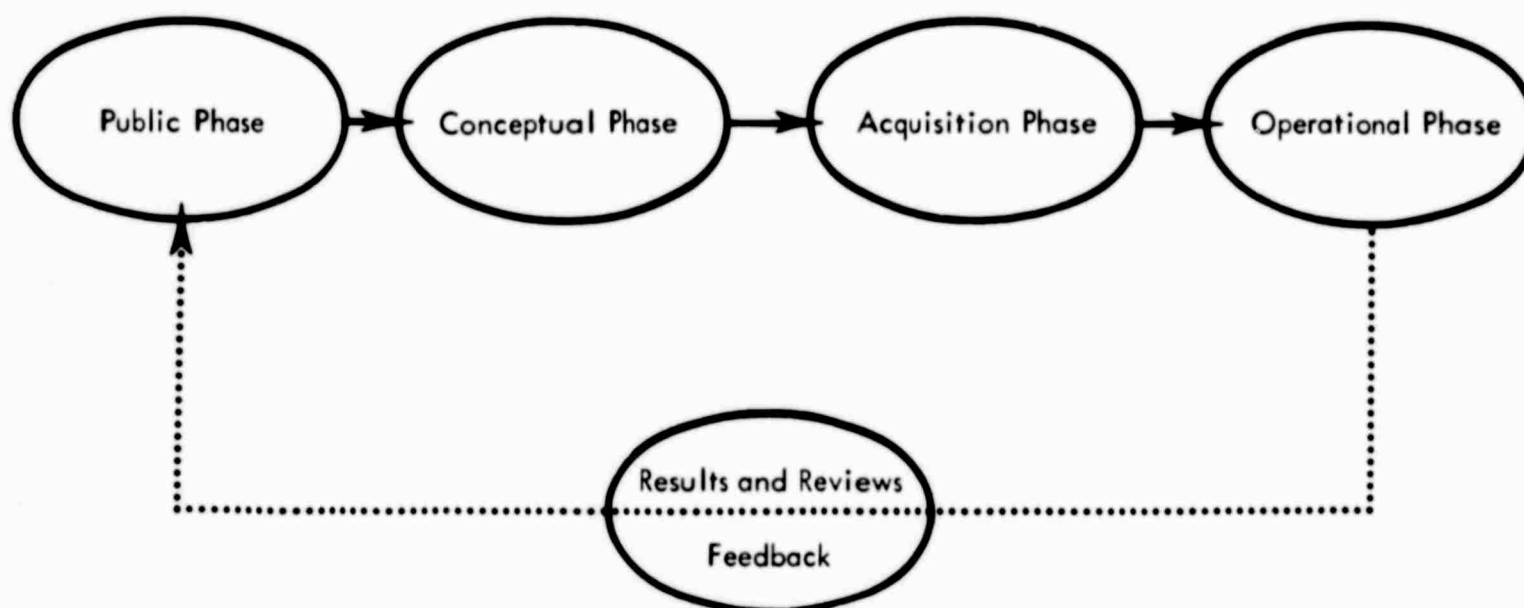


FIG. 4
THE TRANSLATION OF RESOURCES INTO PROGRAMS

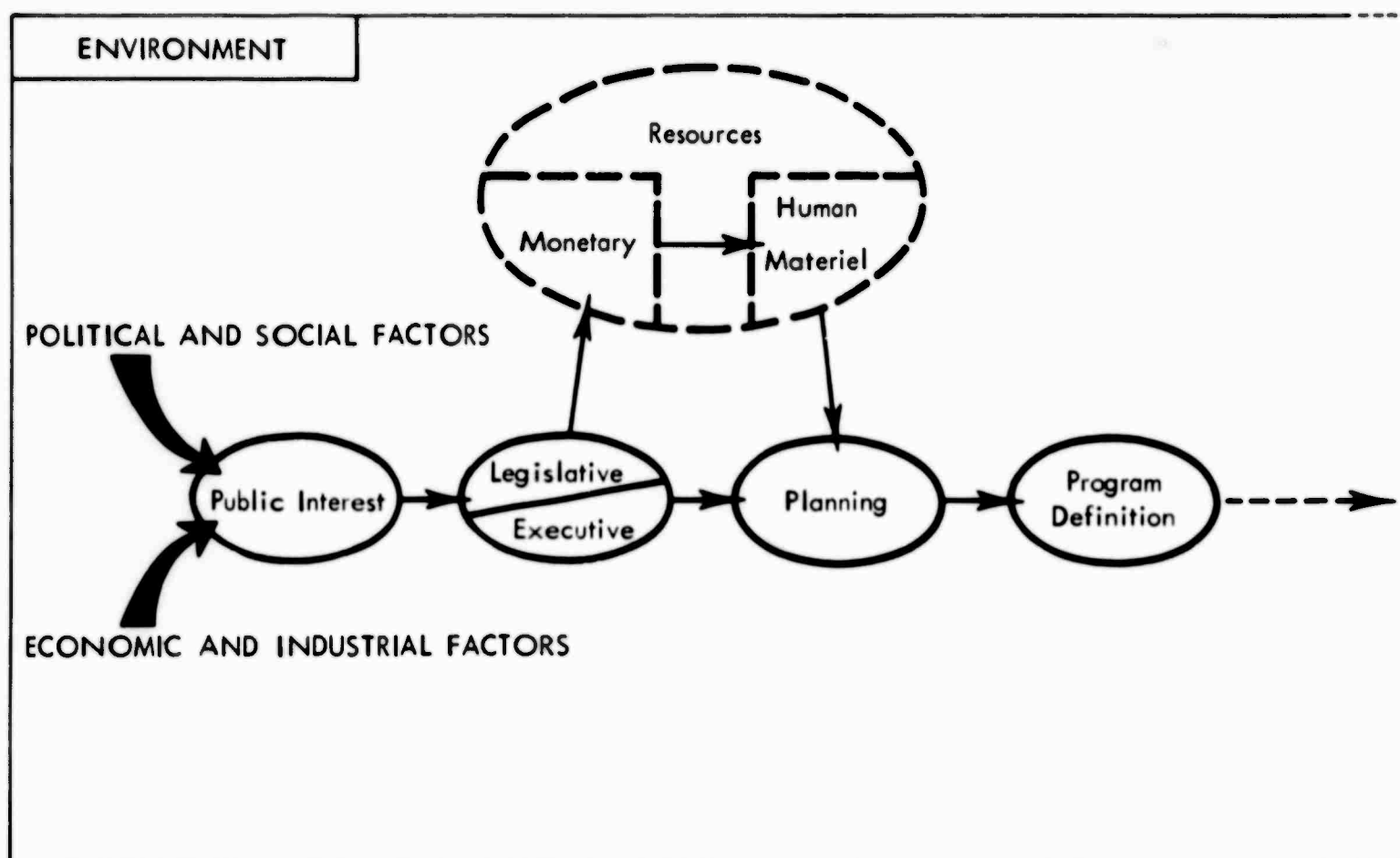
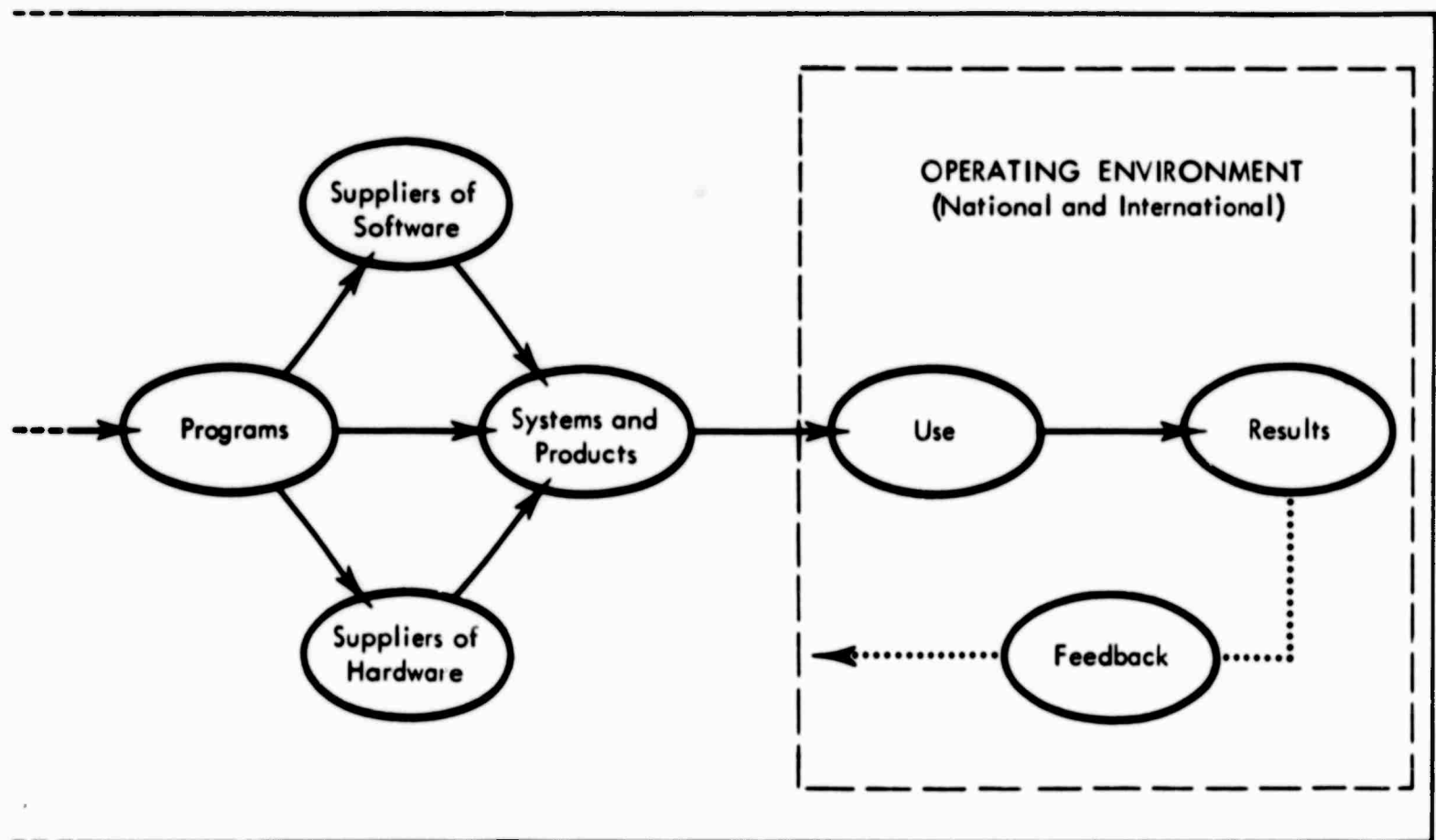


FIG. 5
THE TRANSLATION OF PROGRAMS INTO DESIRED RESULTS



By this means, the various systems are "acquired" and activated by the using agencies. In the case of the military, the purpose is to provide the necessary defense posture or, in the case of the nonmilitary agencies, to support research or other required functions, such as space exploration. The operational results achieved are fed back through government and industry channels to the public and have an impact on the course of future legislative actions and subsequent planning activities.

The simple phrase, "They administer the programs through contracts," is the key to the effectiveness of the relationship between government and industry. The single, binding legal tie between the two parties is the contract. It embodies all the requirements, limitations, and subsidiary tasks that go along with doing business with government. Upon accepting the contract, industry exposes itself to the impact of statutes, regulations, and policies; their intent; their conflicting, duplicating, and sometimes obsolescent purposes; and the burdens of a social-economic nature they impose in addition to those related to the direct purpose of the contract--R&D or hardware.

To the contractor, as well as to the administering agency, only one other aspect of the Relationship equals the contract in its importance--this is the source-selection process, in which, through an increasingly agonizing series of steps, the winning contractor is picked from among his many skilled adversaries. At the same time, current practices call for a more thorough detailing and refinement of specifications and costs than ever before, a step called "program definition."

Whether or not source selection is accomplished as effectively as it might be is a question that goes beyond the scope of this study. One of the greatest current controversies centers around this aspect of the industry-government relationship: Is politics¹ a factor in source selection? The highest policy-makers say it is not. Rumor cites many instances where it is supposed to have been. Contractors who need work sometimes wish it was. But, the effectiveness of the nation's contract award process depends on keeping politics out.

The successful company then proceeds with what amounts to two jobs: the first and most important--to harness and manage technology to assure

1. In this context, "politics" implies considerations beyond those that could normally be included within the purview of a duly constituted Source Selection Board or its equivalent, and therefore outside the limits of responsiveness of any of the bidders' proposals.

effective functioning of the end product; the other--to satisfy all the clauses in the contract. If the contract is large and important enough, the company will have plenty of help on both jobs. Currently, the buying agencies are acting as their own systems managers and, with the help of a Systems Engineering and Technical Direction (SETD) contractor or in-house laboratory, maintain very close surveillance over all technical aspects of the contractor's work.¹ In addition, production and quality control aspects are subject to close scrutiny because of their ultimate possible effect on component reliability. Associated with this technical surveillance, and increasingly on a coordinated basis within the buying agencies, contract surveillance is also maintained--on costs, schedule, subcontracting, break-out, set-asides, small business, labor surplus area preferences, and the many other specific obligations of the holder of the government contract.² This working relationship is of such an intimate nature, each decision or delay--whether by company or government--requiring or causing others, that a fair evaluation of the over-all individual performance of either party becomes difficult.

Many irritating problems arise because of the inconsistencies and rigidity of government policy and practice that have grown out of the basic "checks and balances" philosophy underlying governmental structure.³ Much of the friction arises out of the individual actions of government and industry personnel. It is believed that many of these actions occur because of lack of familiarity of working level personnel with top level policy. Other actions, such as driving for the lowest possible fee or the greatest disallowance or the most possible buried cost, may result from the bases upon which individuals think their job performance is being evaluated. In addition, conflicting and nonspecific regulations, combined with limited individual contract officer training or experience may be factors. All are disruptive to the long-term effectiveness of the Relationship.

The effect of actions of review agencies is particularly noticeable in the Relationship. The General Accounting Office stands out above all others in terms of emotion generated by its activities. By Congressional intent, the attention of the GAO is directed to inefficient and uneconomical operations in government departments and among their contractors.

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1. Appendix C, "Technical Program Management."
 2. See Appendix D, "Burdens on the Procurement Process."
 3. Some of the more important reasons for these problems are brought together in Appendix E, "Impact of Statutes, Regulations, and Policies on Individual Companies."

This results in an emphasis on problem areas and limits reports to findings of the unsatisfactory, without properly relating their significance to the over-all and otherwise creditable operations.

The increase in complexity and novelty of developments in modern weaponry since Korea has caused the evolution of a new professional advisory function in the aerospace field. In addition, there has been a great increase in the use of cost-plus-fixed-fee contracts. These provided a convenient flexibility in the development of systems where their urgency, presumably, precluded adequate precontract definition.

Scientific consultants and government laboratory personnel have traditionally helped to create new weapons and have frequently assisted the military in the improvement of their use of weapons. The rise of a professional advisory function, separately established, serving on a full-time basis is a more recent occurrence. The development of advanced systems concepts, preliminary design configurations, feasibility studies, systems engineering, and the technical direction of the programs are now being performed both by government agencies and by specialized organizations under government contract specifically charged with these tasks. The Aerospace Corporation (Air Force), the MITRE Corp. (Air Force), the Applied Physics Laboratory (Navy), and BELLCOM (NASA) are examples of organizations that have been retained to advise and assist government agencies.

Few industrial contractors quarrel with the basic premise that the government, to do its job properly, must have available to it sufficient expertise in the advanced aerospace technologies. Since the expertise that the government requires must be both impartial and objective, it follows that specialized organizations have an important part to play as technical advisors. They are assisting materially in the "program definition" phase, so important to eliminating the looseness of (or "rubber") specifications that lead to unanticipated expenditures and other problems.

The aerospace industries are not concerned about the existence of these organizations. They are concerned about the fact that these organizations, in their role as technical advisors to government, appear to be taking over a portion of industry's one-time role in conceptualizing new systems and components. These organizations, too, are becoming increasingly active in the conduct of research, the capability for which also exists in industry. In effect, this represents increasing government "in-house" research.

A critical concern of industry is the relatively aloof and sometimes competitive attitude of these special organizations in their consideration of industry's ideas. This is important because the livelihood of industry is increasingly at the R&D level, where proprietary ideas are crucial. In this regard, it is said, however, that companies, increasingly, must be careful not to mix fancy with facts in their proposal submissions.

The use of cost-plus-fixed-fee contracts, in turn, has encouraged admittedly inefficient practices in both industry and government and has led to a number of actions considered necessary by the government under current circumstances but definitely undesirable by industry. These include closer supervision, increased competition to force cost reduction, forced subcontracting, increased rigidity of regulations, and more precise cost principles and cost control measures. Currently, contracts are being superseded where possible with cost-plus-incentive-fee contracts as a means of encouraging improvement in contractor performance.

The preponderance of bargaining strength in the Relationship is clearly on the government's side. Its strength comes through control of funds, definition of goals, timing and technique, encouragement of competition, participation in management, the application of political pressures, and power to terminate contracts and retroactively to reduce prices and profits.

Industry collectively, on the other hand, retains most of the capability, initiative, and creativeness to accomplish the complex tasks that appear necessary to assure the nation's survival. It is industry that is supposed to be able to utilize the nation's resources of manpower, money, and material in the most efficient ways. It is industry that is in a position to recognize the real cost and time delays involved in the government's attempts to utilize defense and space contracts to achieve social and economic ends. It is industry--not government--that could more aggressively lead the way in developing newer and more efficient means of reaching hardware goals. Industry should recognize these possibilities, these challenges, and not dissipate its talents by devoting its entire attention to defending itself, occasionally without justification, and often ineffectively, against what it considers to be over-regulation and "overmanagement" by the government.¹

1. See also E. F. Leathem, "What Fragmenting Authority Has Done to Military Buying," Armed Forces Management, October 1959, p. 32.

Just as the government should be forbearing in the use of its sole customer leverage in dealing with industry, so should industry, through a code of operating principles, avoid what some may construe as unethical practices arising from a tendency, intentional or not, to take advantage of the government's personnel and procedural limitations. "Let the buyer beware" is an attitude that should not apply in this Relationship. Nor should destructive competition be encouraged. Both approaches are too wasteful to be tolerated by either party. The public interest demands a recognition of the need for an appropriate balancing of these requirements.

IMPACTS AND IMPLICATIONS OF THE RELATIONSHIP

The Reshaping of the Participants

No relationship so close, so intense, so large, and so protracted could continue without causing some changes in the nature of the parties concerned. Both internal pressures and external demands are involved. Such changes become more noticeable with the passage of time, and their effects, once stimulated, carry long-term implications for the future.

There are many important changes in process, among which the following are examples:

The balance of power is shifting from the military services to the Office of the Secretary of Defense as it exercises increasing control over the billions of dollars involved in complex weapon development.

The complexity of systems and the lessening number under development is encouraging a new kind of specialist in industry--a few firms, some old-timers and some new, skilled as weapons systems integrators. Other contractors may find themselves more frequently as team members and subcontractors than as team leaders or prime contractors.

Increasingly, in turn, the integrators are being expected to adopt organizational patterns and procedures similar to those employed by their government customers to facilitate the flow of information and exercise of control.

Attempts on the part of the government to avoid encouragement of monopolistic concentrations in the industry have led to detailed specifications for and supervision of the aerospace industry's subcontracting practices.

Also of major significance is the evolution of the competitive structure of the industry. Many of the older companies in the business have tended to diversify and to expand within the defense market. They have built new facilities and have acquired new staffs. At the same time, the government has encouraged the spawning of similar capabilities in other companies, partly to introduce price competition into aerospace procurement activities, and partly to encourage additional capable

people to become aware of and offer solutions for the government's hardware problems. The means used in both cases have been the tremendous increases in government support of R&D. Even modest government support for a company interested in becoming established in this very demanding branch of high-technology industry has helped considerably to foster additional capability. Thus, the government has a much larger group of potential contractors from which to choose than was once the case. At the same time, however, and despite both industry and government attempts to disperse contracts geographically, the viability of selected local economies has become increasingly dependent on continuation of government business. This is thought to result, at least in part, from the tendency for people and companies of similar interests and capabilities to congregate together.

In the next few pages, an attempt will be made to set forth additional evidence of the impacts of the Relationship. Generally speaking, the development of atomic weapons, combined with a realignment of world powers after World War II, triggered a period of international scientific activity never before experienced. In turn came the U.S. strategy of deterrence, an intensification of weapons' development activity, expansion and stabilization of support of high-technology industry in the United States, over-enthusiasm in the commitment of funds for unproved systems, complaints from the government of wasteful use of funds, the missile stalemate, a turning back toward conventional weapons, intensification of Congressional interest in the control and distribution of federal technical spending, elaboration of legislation and regulation, pressure for greater attention to social and economic considerations in contract awards, increasing precision in specifying objectives and in monitoring of contractor progress--and criticism and ill-feeling on all sides.

Impacts on the Industry

The high technology companies involved in the aerospace business today are an aggregate of industrial activities that cut across an ever-increasing portion of U.S. industry. Consequently, they have not been combined in official statistics. Included are aircraft manufacturers, aircraft manufacturers turned missile producers, electronics firms, instrumentation concerns, chemical companies, and miscellaneous precision component and parts manufacturers. Qualitative references in this study to the aerospace industry include this group. Quantitative analyses are based on public information and proprietary information submitted by AIA member companies.

Industry Scope and Activity

Aerospace companies developing and producing parts for and assembling complete aircraft, missiles, and space vehicles had net sales in 1961 of almost \$15 billion, of which \$11.5 billion were to the U.S. government.¹ Total sales of the industry were equal to almost 3% of GNP for 1961, and sales to the federal government were equal to more than 23% of the government's expenditures for national defense.

Employment by aircraft and parts companies rose from about 338,000 in December 1950, to 769,000 for the same month of 1955.² By December 1961, employment by such companies had dropped to 646,000, but was supplemented by additional (estimated to be about 140,000) workers on missiles being manufactured by nonaircraft companies.

The wages paid by aircraft and parts companies rose from \$1.0 billion in 1950 to almost \$4.0 billion in 1955, and to about \$4.5 billion in 1961. The inclusion of compensation received by missile workers in nonaircraft companies, it is estimated, might add one billion to the payroll for 1961.

The total dollar volume of sales by manufacturers of complete aircraft, aircraft engines, propellers, and parts reached a postwar high in 1957 of \$11.75 billion, and has leveled off since then. Whereas manufacturers' sales of aircraft, engines, propellers, and parts by 1960 had declined by almost \$3 billion, their sales of other products and services, including missiles, increased by over \$2 billion.

The number of military aircraft sold began to drop in 1954, but the fly-away value per plane has risen sharply. Nevertheless, total DOD expenditures for production and procurement of aircraft fell from a post-World War II high of \$9.1 billion in 1954 to less than \$6 billion in 1961, while sales of aircraft and parts to other customers rose from about \$800 million to approximately \$2 billion. The value of U.S. aeronautic exports was about \$1 billion in 1957, \$1.3 billion in 1960, and \$1.2 billion in 1961, while imports rose from \$53 million in 1957 to almost \$152 million in 1961.

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1. U.S. Department of Commerce (figures prior to 1961 do not permit other than rough estimates of activity in the aerospace industry, etc.).
 2. U.S. Department of Labor, Bureau of Employment Security.

In recent years, expenditures for aircraft by DOD have been supplemented by expenditures for missiles, which currently are running at about \$3 billion per year. In addition, DOD is currently obligating each year about \$4.4 billion for aerospace research, development, testing, and evaluation. Obligations by NASA for the conduct of research and development are expanding rapidly and are expected soon to exceed \$5 billion a year. In 1961, NASA spent almost \$500 million for this purpose and another \$100 million for research and development plants. The coverage of activities included in R&D has been broadened with the passage of time, but the real growth trend, except possibly for basic undirected research, is unmistakable.

A study of the nature and location of principal prime contractor facilities and subcontracting practices has revealed many changes.¹ From 41 major prime facilities in 1946, the number has grown to over 100 in 1962. Only 7 of the 13 largest airframe producers still make airframes. On the other hand, electronics companies operate 17 major facilities today, whereas only 4 existed in 1946. As for subcontracting, it is significant in amount, but nothing has really been accomplished in diffusing the geographical peaks of prime contract awards. A spot study of the subcontracting patterns of eight prime facilities revealed only an enhancement of prime contracts concentrations.

Many of the companies involved were born during the 1920's and 1930's, with a determination to do what others could not, when the technical challenges were more of an engineering than a scientific nature. These companies were raised on the almost unlimited need for advanced hardware during World War II. They are now coming of age during the current period of high and relatively stable effort, in which they, as well as many more recently organized companies, are engaged in provisioning cold war and space programs.

The uniqueness of the industry rests on four major accomplishments:

1. It has successfully applied advanced technology to hardware.
2. It has produced large quantities of such hardware for its principal customer, the government.
3. It has survived periods of great uncertainty and very little business.

1. See Appendix D, "Burdens on the Procurement Process."

4. It has adapted itself readily to the technical challenges of the space age.

That this transition has been accomplished relatively successfully is a tribute to the industry's management, as well as to the many farsighted government officials with whom the industry has worked.

The industry was bred on change, with its managements' attention caught up in rapid expansion and precipitous contraction of business, as well as in dramatic advances in technology. The industry is now experiencing its first period of relatively high and stable volume of business, where more of management's attention should be given to costs, specifications, and procedures. Another difference between yesterday and today is that now the product is much more complex, and much more of the nation's welfare is at stake in each item than formerly. Whereas during World War II days the value of the product was about \$10 per pound, and in the 1950's about \$100 per pound, its value today (in missile and space hardware) is running at more than \$1,000 per pound.

The tests of maturity for the industry are far from over, however. In addition to advancing technology, increasing attention to R&D, lower production quantities and greater cost of its product, the industry's future will be affected by government efforts to (1) centralize the control of procurement and limit the number of major systems under development, (2) increase competition, (3) add to risk by a greater use of incentive contracts, and (4) more closely supervise the work in process. All this has come about because of the increasing significance of the defense and space budgets and the public concern over the effective employment of the funds involved. Whether or not, in the face of these moves, the industry can maintain its initiative and unique abilities remains to be seen.

The broadening of industry categories participating in aerospace activity has, in turn, increased the number of "voices," trade associations and otherwise, speaking for the industry in Washington, but without unanimity. Amidst this democratic dissidence, the Secretary of Defense recently created a special Defense Industry Advisory Council to provide a forum for consideration of industry's point of view and problems. However, it does not include representatives of many government agencies important to the industry, nor are representatives of the public included. Its effectiveness will be based on the good will and influence of its members.

The Industry's Financial Profile

Study of the financial profile of selected aerospace companies reveals changes in the industry that in most cases have come about because of the terms of the government contract relationship.

The profile consists of:

1. Analyses of selected financial aspects of the aerospace companies based largely on their replies to an SRI questionnaire.¹
2. A comparison, based largely on published data, between
 - a. The rates of return of selected aerospace companies, and
 - b. A broad cross-section, prepared by SRI, of over 100 large manufacturing corporations.²

Since the end of World War II, the aerospace industry has gone through three periods of major change:

1947-51 - Characterized by the low volume of business in the initial postwar period

1952-56 - Covering the expansion in aircraft production during and following the Korean fighting and the accompanying deterioration in the international situation

1957-61 - Characterized by relative stability in total sales and by the transition from long production runs to research, development, test, and evaluation contracts for missiles and space systems

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1. Since not all of the responding companies answered all questions for all years, the coverage varies for different phases of the analysis reported.
 2. Throughout this analysis, return on total assets and return on net worth, unless otherwise stated, are before adjustment for refunds claimed by the Renegotiation Board. The aerospace companies studied in this report have contested some \$133 million of these claims before the Tax Court of the United States, and most of the cases are still undecided.

The wide and often erratic annual fluctuations in the measures of aerospace industry performance argue for considering results over a span of years. This is done in the following material for aerospace companies considered to be relatively representative. Some of the more important findings follow.¹

Sales

Distinguishing characteristics of the aerospace industry are the rapid growth and wide fluctuations in its level of sales and production. The aggregate aerospace sales of 16 reporting companies rose from \$7.8 billion in the 1947-51 period to \$32.5 billion in 1952-56. This greater than fourfold increase reflects the shift from low postwar production to the expansion resulting from the changing international environment.

Growth continued, but at a far slower rate during the 1957-61 period. Aerospace sales for the 16 companies rose to approximately \$50 billion in 1957-61, or an increase of about 54%.

The proportions of government and commercial sales varied considerably among the companies and, during the period, for several of the individual companies. For the entire 15-year period, sales to the federal government aggregated \$81.5 billion or 89% of total sales.

Changes in Types of Work and Contracts

Aggregate sales figures do not reveal significant changes in the relative importance of R&D, on the one hand, and production runs, on the other hand. For example, research and development, for 12 companies providing this information, fell from 11.5% of sales in 1947 to less than 5% in 1953 and 1954, then rose to about 21% in 1960 and 1961. The growing importance of R&D and the production of prototypes and their testing and evaluation have been accompanied by an increasing use of cost-plus type contracts. These rose from about 26% of government sales in 1949 to approximately 58% of such sales in 1961.

1. For additional analyses, definitions of terms, and other details, see Appendix G, "Financial Profile of the Industry."

Facilities

Still another distinguishing characteristic of the aerospace industry has been the relatively limited amount of its fixed assets that are company-owned as compared with production performed. However, during the 15-year period 1947-61, the 22 aerospace companies reporting on this point expended a total of \$2.1 billion for plant and equipment. This amount is equivalent to 14.9 times the depreciated book value of plant and equipment owned by these companies in 1947. The bulk of these expenditures were made during the 5-year period 1957-61.

The excess of outlays for plant and equipment above annual depreciation and amortization charges is equivalent to 36% of the companies' net profits during the 15-year period, before adjustment for renegotiation.

On the basis of information supplied by 12 companies, during 1952-56 the value of government-supplied plant and equipment was 69% greater than company-owned property. In the 1957-61 period government-supplied property was only 5% greater than company-owned property--a substantial reduction in industry dependence on government facility support.

Despite this major growth in its plant and equipment, the aerospace industry consistently shows a higher amount of sales per dollar of property (net of depreciation) than manufacturing companies generally. In 1957-61, the industry had average sales of approximately \$13.60 per dollar of property as contrasted with an average of \$3.70 for a representative cross-section of major American manufacturing companies. This differential of nearly 4 times was exceeded in the 1947-61 time span taken as a whole.

The reason for this differential can, of course, be accounted for on the basis of government-supplied facilities. However, even with proper adjustments for the use of these facilities, the aerospace rate of sales per dollar of facilities is more than twice as high as that of the cross-section group.

Subcontracting and Value Added

Similar to most aspects of the aerospace industry, the percent of subcontracting and other outside purchases to net sales varied widely for different companies and for individual companies in different years. It declined from 1948 to 1953 as the industry expanded its volume of aircraft production. Although sales continued to climb in subsequent

years, the newer products involved and the sizable outlays for new kinds of plants and equipment gave the industry an opportunity to again increase its in-house work. The stability in the value added ratio since 1958 appears to reflect a balancing of the upward pressure of corporate diversification and the growth of research and development (most of which is typically done in-house) by the opposing pressure of government subcontracting requirements.

The weighted average of the percent of subcontracting for a representative group of the aerospace companies was 45% for the 14-year period 1948-61, indicating that approximately 55% of the value of the net sales of these companies was created in-house. Value added by manufacture is another way of looking at the extent to which work was done in-house. For the same 14-year span, the weighted average of value added by 22 aerospace companies was 52% of total costs and expenses, adjusted for changes in inventory. This percent of value added by these aerospace companies places them, in terms of in-house work, among such industries as rubber and plastic products, and chemicals and related products, but above the average of 44% "value added" by "all" manufacturing.

Other observations can be made on the basis of an analysis of value added:

1. The growth in value added per employee over the 14-year period 1948-61 is clearly greater than price increases.
2. A preliminary examination reveals no correlation between value added and rates of return for groups of aerospace companies.
3. In general, aerospace companies doing more than 90% of their business with the government subcontract a higher percentage of their sales dollar than aerospace companies with between 60% and 89% government sales. Comparative figures are 48% and 43%, respectively.

The Financing of Research and Development

Data from 11 aerospace companies show that their total R&D expenditures rose from about \$100 million in 1947 to over \$2.1 billion in 1961. Over the 15 years, 84% of this R&D was government-sponsored and government-financed, and another 10% was company-sponsored but financed by the government through indirect charges to government contracts; less than 6% of total expenditures for R&D was company-sponsored and financed. For

the 15-year period, total R&D expenditures averaged 17.5% of sales (16.5% government-financed and 1% company-financed). The significance of this 1% for firms with such low profit margins as the aerospace industry is more clearly revealed by relating such expenditures to pretax net income. Omitting 1947 because of a gap in the data, and 1959 and 1960 because of distortions introduced by the losses reported by Douglas and Lockheed, company-financed R&D averaged about 12.5% of the pretax net income for the 11 firms for the 12 years 1948-58, and 1961.

Unrecoverable Costs

Disallowances and other costs not recoverable on government contracts rose from 0.4% of government sales of 15 aerospace companies in 1953 to 1.0% of such sales in 1960. Data are not available for all 15 companies for 1961. These unrecoverable costs equaled 14% of the pretax net income of these 15 companies in 1958. (For years subsequent to 1958, this percentage was distorted because of large commercial losses.)

As the aerospace industry has increased its indebtedness to finance its capital requirements, interest expense, the largest of those costs not allowable, has increased significantly--from \$1 million in 1950 (for 12 aerospace firms), to \$4 million in 1955, and to \$26 million, or about 8% of its operating profits, in 1961. Other major disallowables include advertising and selling and company sponsored R&D. The increase in percentage of unrecoverable costs over the years has resulted, in part, because of increases in these major expenses and, partly, because the list of disallowable costs is lengthening.

Profitability

A composite profit-and-loss statement for 12 aerospace companies comparing 1950, 1955, and 1961 shows that net profit (after taxes, but before rulings of the Tax Court of the United States on renegotiation cases) declined from 4.4% of sales in 1950, to 3.3% in 1955, and to 1.9% in 1961. From 1950 to 1961, wages and salaries as a percent of sales fell from 42.6% to 37.6%, while cost of materials and supplies rose from 36.9% to 44.5% of sales.

Rulings by the Tax Court of the United States in five cases affecting three of the aerospace companies studied in the foregoing reduced the weighted-average-after-tax return on the reported average total assets of these companies from 8.8% to 7.4%, and on their net worth from 23.3% to 19.2% for the years affected.

The aerospace divisions of five large diversified corporations with substantial nonaerospace commercial business show weighted-average profit margin (earnings available for net worth as a percent of aerospace sales) to be slightly lower than the margin on all other sales by their corporations.

For the 15-year span 1947-61, and 20 aerospace firms analyzed, the weighted average of dividends paid was 55% of net income after renegotiation.

Rate of Return Comparisons

The preceding summarization of selected financial aspects of the aerospace industry reveals some significant changes. To add perspective, the industry is compared, in the following paragraphs, with general U.S. manufacturing industry on the basis of effectiveness with which financial resources are employed.

A rate-of-return approach is employed here because it provides a comprehensive analytical framework and a more effective means for measuring and comparing the long-run profitability of individual companies or groups of companies than do the absolute dollar amounts.

This study focuses on the rate of return on total assets because the rate provides a comprehensive measure of performance. In our opinion, it is a better basis for comparing the results of businesses with dissimilar financial structures than other methods currently employed. The return earned by a company on total assets is a measure of the profitability of the enterprise as an economic entity. This single figure indicates the effectiveness--from a profit standpoint--with which all of a firm's economic resources are employed. In this sense, it is more of an over-all measure of earnings' performance than either the return on total capital or net worth. Moreover, since the nature of the financing methods employed by a company can significantly influence the return¹ earned either on total capital or net worth, the return on total assets

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1. The return on total assets is the product of: (1) "assets earnings margin" (profit margin on sales adjusted to take into account the fact that interest payments by a company are a form of return on its assets--i.e., ratio of earnings available for total assets/sales), and (2) "turnover of total assets" (ratio of sales per dollar of total assets).

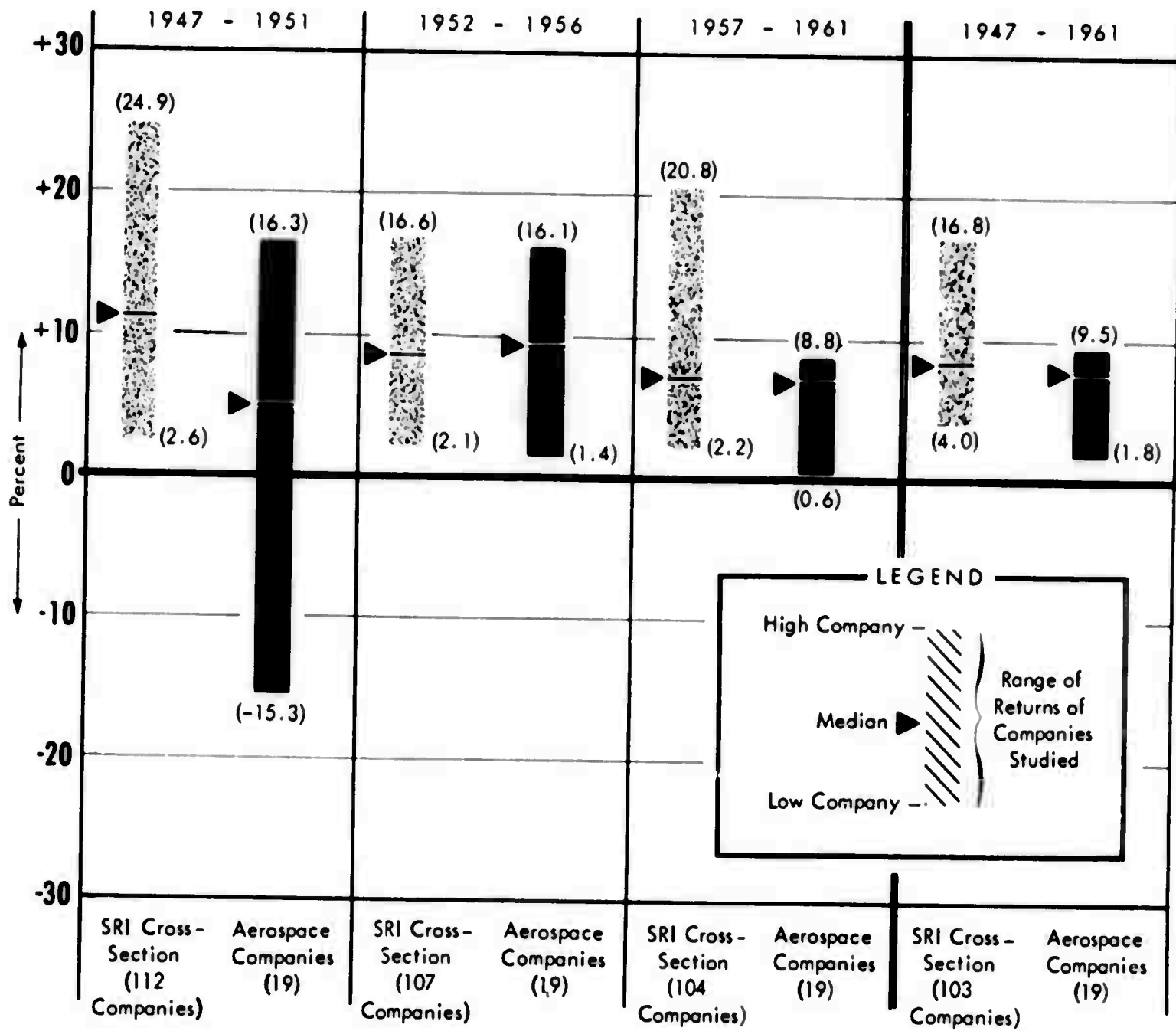
provides a more comparable measure of the profitability of groups of companies, either in terms of one another or over time.

The study reveals that the median return on total assets for 19 aerospace companies is below that for the SRI cross-section of over 100 manufacturing concerns for each period except 1952-56, and the aerospace weighted average is below that for the cross-section for all periods. None of the aerospace firms matched the high for the cross-section, and at least one aerospace firm had a lower return than any cross-section company for all periods studied. Figure 6 and Table I summarize the findings. Briefly, for the 1957-61 period, the median return on aggregated total assets for the 19 firms was 7.1%, which compares with a median of 7.3% for a broad cross-section of 104 large manufacturing corporations. The weighted average return of the aerospace companies was 5.2% for the 1957-61 period, as compared with 8.1% for the cross-section group.

Information on return on net worth should be noted as a key ratio if for no other reason than the weight that it has received in renegotiation proceedings. Briefly summarized, the median return on net worth earned by the 19 aerospace companies in the 1957-61 period was 11.3%, which compares with a median for the cross-section group of 9.8%. The relatively more favorable return on aerospace net worth is due to the greater leverage, and consequently greater risk, in this industry that results from the ratio of net worth to total owned assets being substantially lower than for the cross-section of manufacturing. The weighted-average return for the aerospace firms was 9.1%, as compared with 10.8% for the cross-section group. This less favorable comparison is the result of the industry's commercial aircraft losses. See Figure 7 and Table I.

This study does not consider whether the rate of return earned by the selected aerospace companies will be adequate to perform the economic function of profits, which is to mobilize and maintain resources. Considering today's heavy competition for all contract awards, the profit rate appears to have been sufficient to mobilize more than adequate resources. On the other hand, the industry is in a transitional stage as far as assumption of risk is concerned. Much of the industry has been housed in government facilities and, until 1957, a significant portion of the industry's working capital was provided by generous government progress payment rules. Only within the last six years have facility funding by the government and the rate of progress payments been reduced. The industry has been expected to fill the gap out of reserves, profits, and other sources of capital funding. Whether or not the current profit rate is sufficient to assure continuing availability of adequate industrial

FIG. 6
RETURN ON TOTAL ASSETS, 19 AEROSPACE COMPANIES AND SRI
CROSS-SECTION OF U.S. MANUFACTURING



NOTE: Before adjustment for results of claims for refunds by The Renegotiation Board.

SOURCE: Stanford Research Institute.

Table I

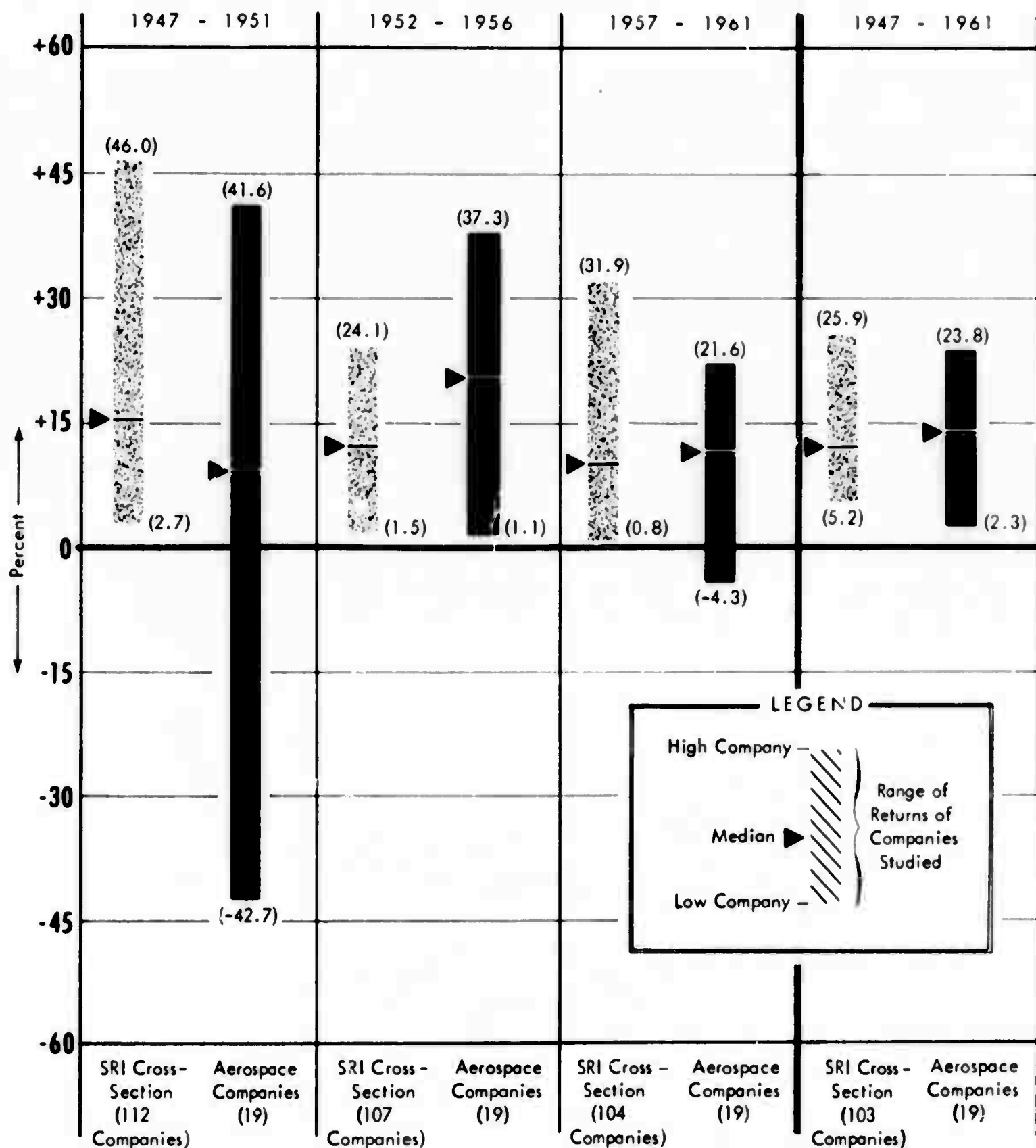
COMPARISON OF 19 AEROSPACE COMPANIES
WITH SRI CROSS-SECTION OF MANUFACTURING^a

	<u>1947-51</u>	<u>1952-56</u>	<u>1957-61</u>	<u>1947-61</u>
Return on total assets (%)				
Aerospace high	16.3	16.1	8.8	9.5
Cross-section high	24.9	16.6	20.8	16.8
Aerospace low	(15.3)	1.4	(0.6)	1.8
Cross-section low	2.6	2.1	2.2	4.0
Aerospace median	5.0	9.7	7.1	7.4
Cross-section median	11.2	8.6	7.3	8.3
Aerospace weighted average	4.9	9.1	5.0	6.3
Cross-section weighted average	11.1	9.8	8.1	9.3
Assets earnings margin (%)				
Aerospace high	8.0	5.4	5.3	4.9
Cross-section high	23.5	21.1	16.9	18.9
Aerospace low	(18.9)	0.7	(0.2)	0.7
Cross-section low	0.4	0.7	0.6	0.8
Aerospace median	3.1	3.3	2.9	3.1
Cross-section median	7.8	6.2	5.9	6.4
Aerospace weighted average	3.1	3.3	2.1	2.6
Cross-section weighted average	7.9	7.5	7.1	7.4
Turnover of total assets (x)				
Aerospace high	3.68	4.45	3.07	3.39
Cross-section high	6.26	5.68	5.24	5.79
Aerospace low	0.80	1.76	1.36	1.53
Cross-section low	0.60	0.64	0.56	0.60
Aerospace median	1.65	2.69	2.44	2.39
Cross-section median	1.47	1.32	1.27	1.29
Aerospace weighted average	1.60	2.79	2.43	2.42
Cross-section weighted average	1.40	1.30	1.13	1.25
Return on net worth (%)				
Aerospace high	41.6	37.3	21.6	23.8
Cross-section high	46.0	24.1	31.9	25.9
Aerospace low	(42.7)	1.1	(4.3)	2.3
Cross-section low	2.9	1.5	0.8	5.2
Aerospace median	9.5	20.8	11.3	13.8
Cross-section median	15.8	12.0	9.8	11.7
Aerospace weighted average	7.3	19.5	8.9	11.7
Cross-section weighted average	15.5	13.6	10.8	12.7

a. For definitions of terms, consult Appendix G.

Source: Derived by Stanford Research Institute.

FIG. 7
RETURN ON NET WORTH, 19 AEROSPACE COMPANIES AND SRI
CROSS-SECTION OF U.S. MANUFACTURING



NOTE: Before adjustment for results of claims for refunds by The Renegotiation Board.

SOURCE: Stanford Research Institute.

capability is a question that remains to be answered. Such availability would require not only an analysis of the risk associated with government dominance of the market but an appraisal of the cost of maintaining adequate know-how and facilities in the continuously obsolescing technology on which the industry is based.

Technical Profile

Employee skill-mix and floorspace utilization are two measures that reveal the impact of recent changes in the Relationship on products and technical resource requirements.¹ The changes in employee skill requirements that have occurred between 1947 and 1961 are summarized in Table II. Particularly noteworthy are the decreasing proportion of production workers, the increasing percentage of scientists and engineers involved in the creation of newer systems, and the startling increase in salaried employees other than scientists and engineers. The demand for personnel in management, scheduling and control, procurement and services has increased 163% between 1955 and 1961, as compared with 113% for scientists and engineers. A significant part of the increase in "other salaried" employees can be laid to the growing accumulation of regulations, audits, and management liaison and control systems, such as PERT, associated with government procurement.

The 16.3% of all aerospace employees who are engineers and scientists is 6 times as great as the all-industry average of 2.8%. The industry, in fact, employs almost 20% of the country's available technical talent.

As might be anticipated from the changing relation between manufacturing and salaried employees, floorspace utilization has also shifted markedly. Details are shown in Table III. In 1961, based on information from 28 reporting companies, only 7 companies were utilizing more than 50% of their floorspace for manufacturing. On the other hand, 14 reported utilizing more than 25% of their space for laboratories and offices, a doubling of those so disposed since 1955. We see here evidence of a most important change in the industry. Increasingly, the industry is becoming something similar to an "architect-engineer" activity rather than a "construction" operation. For system-integrator type firms, the production talents of others are being depended upon to manufacture the pieces of the elaborate systems desired. The full significance of these

1. See Appendix H, "Technical Profile of the Industry."

Table II

MANPOWER COMPOSITION OF SELECTED AEROSPACE ACTIVITIES
1947, 1955, and 1961

	<u>1947</u>	<u>1955</u>	<u>1961</u>
Total manpower in activities surveyed ^a	50,288	311,611	399,384
Hourly employees as percent of total	77.5%	76.0%	54.4%
Total salaried employees as percent of total	22.5%	25.0%	45.6%
Engineers and scientists (salaried) as percent of total	10.2%	9.8%	16.3%
Other salaried employees	12.3%	14.2%	29.3%
Technicians as percent of total	2.9%	4.2%	6.1%
Technicians per 100 engineers and scientists	28	42	37

a. Nineteen companies reported manpower data for twenty-six activities for 1961; eighteen of the same companies reported comparable data for twenty-three activities for 1955; nine of the same companies reported comparable data for nine activities for 1947.

Source: Stanford Research Institute.

Table III

FLOORSPACE ALLOCATION IN SELECTED AEROSPACE ACTIVITIES
1947, 1955, and 1961

	<u>1947</u>	<u>1955</u>	<u>1961</u>
Total floorspace in activities surveyed ^a (millions of square feet)	24.4	92.1	129.9
Total floorspace utilized (millions of square feet)	23.5	90.1	125.3
Manufacturing floorspace as percent of total utilized floorspace	53.5%	51.7%	39.9%
Laboratory and office floorspace as percent of total utilized floorspace	21.1%	17.9%	28.4%
Storage floorspace as percent of total utilized floorspace	13.2%	14.6%	14.4%
Other uses as percent of total floorspace used	12.2%	15.8%	18.3%

a. Nineteen companies reported floorspace data for twenty-eight of their activities for 1961; seventeen of them provided comparable data for twenty-three of their activities for 1955; and twelve of them, comparable data on twelve activities for 1947.

Source: Stanford Research Institute.

changes is only now becoming apparent as the industry readjusts its thinking on apportionment of overhead costs. Traditionally, the industry recouped the major portion of its costs from overhead charges on its extensive production activities.

Impact on Government Activities

Although much less susceptible to statistical treatment than industrial changes, the evolution occurring within the government itself is of equal significance to the future effectiveness of the Relationship.

One of the more significant changes is taking place in DOD. It involves centralization of technical planning, review, and program budgeting to give the Secretary of Defense closer control over weapons programs. This, more than any other move, is shifting the balance of power within the Relationship in a way that will, increasingly, have a most far-reaching effect on the industry.¹ The results are already being felt in a curbing of the proliferation of individual military service-sponsored competitive systems. The number of weapons under development has been reduced, as has the number of prime contracts.

A further aspect of the centralizing effort is an added formalization and standardization of procedures, including reporting and accounting practices, in both the DOD and industry segments of the Relationship. Moves are being made at the OSD level to consolidate and simplify reports expected of industry, a task long overdue. The extensive Aircraft Manufacturers Planning Report and the Missiles Manufacturers Planning Report are being replaced by a Defense Contracting Planning Report. About 20 report forms currently being prepared by industry have been eliminated, representing a significant improvement. It is only the beginning, however. Even this move was taken, admittedly, without full justification of the continuing need for the information requested. Studies are under way that will clarify this situation. The results will certainly involve the placing of more uniform, if not additional, information requirements upon industry. In addition, the move toward standardized

1. In this regard, a quote from S. P. Huntington, The Common Defense, (New York: Columbia University Press, 1961), may be prophetic. ". . . the castles of the services, like many of their medieval counterparts, will remain in existence, battered but untaken, long after the decisive battles--both political and military--have shifted to other fields."

accounting is expected to facilitate the government's efforts to monitor contractor costs. This may add to contractors' difficulties in covering all the costs associated with effective government contracting. Some analysts maintain that the industry's accounting systems have probably evolved just as much out of a need to obscure costs as to control them.¹

The emergence of NASA as an additional major buyer of advanced technology systems from the same suppliers as those used by DOD and AEC is increasing the pressure to standardize the procurement regulations employed by these agencies in their dealings with industry. To the extent that this may result in a combination of the better elements of the regulations of each agency, this could be helpful to industry in decreasing restrictiveness as well as to simplify and reduce the out-of-pocket cost of dealing with the government. It could, however, go in the other direction, toward generally less favorable consideration of industry costs than is the case at present.

The extensive support by DOD of the sciences related to weapons and space technology, combined with increased support for science from other quarters in the government, is precipitating another change of significance to the members of the Relationship. This is the effort currently under way to establish a point of coordination for government R&D planning activities in the National Science Foundation, under the auspices of the White House Office of Science and Technology. A master R&D planning effort could evolve.

Other trends include increased attention to means for fighting conventional wars and procurement of generalized systems useful to all of the military services rather than specialized items. These are also significant, even though they relate more to emphasis than organizational moves.

In summary, ability to respond to change, be it in terms of challenge or threat, technology or technique, is the basic purpose of the Relationship. Whatever may be its frustrations to industry or to government, the Relationship is a necessary one, but there is a clear imperative for its improvement.

* * *

1. Peck and Scherer, The Weapons Acquisition Process: An Economic Analysis, Harvard University, Boston, Mass., 1962, p. 518.

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